| FORM PTO-1390 (Modified) (REV 11-98) | U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE | ATTORNEY'S DOCKET NUMBER |
|---|---|---|
| **TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371** | | **T2147-907162** |
| | | U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR **09/831876** |

| INTERNATIONAL APPLICATION NO. PCT/FR00/02470 | INTERNATIONAL FILING DATE 09/07/00 | PRIORITY DATE CLAIMED 09/16/99 |
|---|---|---|

TITLE OF INVENTION
**METHOD FOR REDUCING CONGESTION IN A NETWORK**

APPLICANT(S) FOR DO/EO/US
**Nadine FABIANO, Bernard MAINGEUENAUD, Rene MARTIN**

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.

2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.

3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).

4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))

    a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).

    b. ☒ has been transmitted by the International Bureau.

    c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).

6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. ☒ A copy of the International Search Report (PCT/ISA/210).

8. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))

    a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).

    b. ☐ have been transmitted by the International Bureau.

    c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.

    d. ☐ have not been made and will not be made.

9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).

11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).

12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

**Items 13 to 20 below concern document(s) or information included:**

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

15. ☒ A **FIRST** preliminary amendment.

16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.

17. ☐ A substitute specification.

18. ☒ A change of power of attorney and/or address letter.

19. ☐ Certificate of Mailing by Express Mail

20. ☒ Other items or information:

> **Verification of Translation**
> **Early Notification of Serial Number Card**
> **Copies of PCT Documents: PCT/IB/308, PCT/IB/301, PCT/RO/101, PCT/ISA/220**

PCTUS1/REV03

| U.S. APPLIC... NO... ... CFR  09/831876 | INTERNATIONAL APPLICATION NO. PCT/FR00/02470 | ATTORNEY'S DOCKET NUMBER T2147-907162 |
|---|---|---|

21.     The following fees are submitted:.

**BASIC NATIONAL FEE ( 37 CFR 1.492 (a) (1) - (5)) :**

| | | | CALCULATIONS   PTO USE ONLY |
|---|---|---|---|
| ☐ | Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO . . . . . . . . . . . | **$1,000.00** | |
| ☒ | International preliminary examination fee (37 CFR 1.482) not paid to USPTO but Internation Search Report prepared by the EPO or JPO . . . . . . . . . | **$860.00** | |
| ☐ | International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO . . . . . . . . . . . | **$710.00** | |
| ☐ | International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) . . . . . . . . . . . | **$690.00** | |
| ☐ | International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) . . . . . . . . . | **$100.00** | |

| **ENTER APPROPRIATE BASIC FEE AMOUNT =** | **$860.00** | |
|---|---|---|
| Surcharge of **$130.00** for furnishing the oath or declaration later than  ☐ 20   ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)). | **$0.00** | |

| CLAIMS | NUMBER FILED | NUMBER EXTRA | RATE | | |
|---|---|---|---|---|---|
| Total claims | 5       - 20 = | 0 | x   $18.00 | **$0.00** | |
| Independent claims | 2       - 3 = | 0 | x   $80.00 | **$0.00** | |
| Multiple Dependent Claims (**check if applicable**). | | | ☐ | **$0.00** | |

| **TOTAL OF ABOVE CALCULATIONS     =** | **$860.00** | |
|---|---|---|
| Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (**check if applicable**).  ☐ | **$0.00** | |

| **SUBTOTAL  =** | **$860.00** | |
|---|---|---|
| Processing fee of **$130.00** for furnishing the English translation later than  ☐ 20   ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).  + | **$0.00** | |

| **TOTAL NATIONAL FEE     =** | **$860.00** | |
|---|---|---|
| Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (**check if applicable**).  ☒ | **$40.00** | |

| **TOTAL FEES ENCLOSED     =** | **$900.00** | |
|---|---|---|
| | Amount to be: refunded | $ |
| | charged | $ |

☒     A check in the amount of **$900.00**        to cover the above fees is enclosed.

☐     Please charge my Deposit Account No.                    in the amount of                    to cover the above fees.
        A duplicate copy of this sheet is enclosed.

☒     The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment
        to Deposit Account No.     **50-1165**     A duplicate copy of this sheet is enclosed.

**NOTE:  Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR
1.137(a) or (b)) must be filed and granted to restore the application to pending status.**

SEND ALL CORRESPONDENCE TO:

| Miles & Stockbridge P.C. Edward J. Kondracki 1751 Pinnacle Drive Suite 500 McLean, Virginia, 22102 US | |
|---|---|

SIGNATURE

**Edward J. Kondracki**

NAME

**20,604**

REGISTRATION NUMBER

**05/16/01**

DATE

Docket No.: T2147-907162

## UNITED STATES DESIGNATED/ELECTED OFFICE (D.O./E.O./US)

Applicant:            Nadine FABIANO et al.

International
Application No.:      PCT/FR00/02470

International
Filing Date:         7 September, 2000

U.S. Serial No.:     To be Assigned

U.S. Filing Date:    May 16, 2001

For:    METHOD FOR REDUCING CONGESTION IN A NETWORK

McLean, Virginia
May 16, 2001

## PRELIMINARY AMENDMENT

Honorable Commissioner of Patents and Trademarks
Washington DC 20231


Sir:

        Please amend the subject application, filed concurrently herewith, as indicated

below:


## IN THE SPECIFICATION:

        After the title and before the first paragraph on page 1, insert the following

heading at the left-hand margin:


--CROSS REFERENCE TO RELATED APPLICATION--

insert the following new paragraph at the left-hand margin:


        --The subject matter of this invention is related to application Serial No.

_____, filed _____, Attorney Docket No. T2147-901763, in the names of

Jean-Yves DUJONC an Rene MARTIN, entitled "RELAY FOR ACCESSING A SERVER NETWORK, TRANSPARENT TO A CLIENT NETWORK" and corresponding French Application No. 99 11594 and PCT Application No. PCT/FR00/02469, incorporated herein in its entirety.--;

Page 1, line 1, before the paragraph beginning "The field of the invention..." insert the following heading at the left-hand margin:

--FIELD OF THE INVENTION--;

Delete the paragraph beginning on Page 1, line 3, with "The field of the invention..." and substitute the following new paragraph:

--The field of the invention is that of communication networks and are more particularly, communication networks using data terminal equipment units (DTEs) adapted to use various protocols.--

Page 1, line 5, before the paragraph beginning "Normally, there are..." insert the following heading at the left-hand margin:

--DESCRIPTION OF RELATED ART--;

Page 3, line 1, before the paragraph beginning "The subject of..." insert the following heading at the left-hand margin:

--SUMMARY OF THE INVENTION--;

Page 3, line 22, before the paragraph beginning "A preferred exemplary..." insert the following heading at the left-hand margin:

-- BRIEF DESCRIPTION OF THE DRAWINGS--;

Page 3, line 29, before the paragraph beginning "Referring to Fig. 1,..." insert a paragraph indentation and the following heading at the left-hand margin:

--DESCRIPTION OF THE INVENTIVE EMBODIMENTS--;

Delete the formula on Page 7, line 21, and substitute with the following new formula:

-- $VFER = VFEp - Diff.$ --

Page 8, line 35, insert the following new paragraph at the left-hand margin:

-- It should be clear to those skilled in the art that the present invention allows for embodiments in many other specific forms without going beyond the scope of application of the invention as claimed. Consequently, the present embodiments should be considered as examples which can be modified within the range defined by the true spirit and scope of the invention as set forth in the attached claims to which resort should be made for a full and complete understanding of the full scope of the invention.--

**IN THE CLAIMS:**

Delete Claim 1, and substitute the following new Claim:

1      --1.    A method for reducing congestion in a network layer (16) of a router

2      machine (15) when aid network layer (16) accumulates in a queue (20) datagrams

3      (12) to be transmitted through a first network (18), comprising:

4      - a first step (29) that measures a fullness level of said queue (20), in order to

5      generate a signal (NIV) based on said fullness level;

6      - a second step (30) detecting any datagram received from said network (18),

7      wherein a field (28) of a first transport layer (6) contains a received window value

8      (VFR);

9      - a third step (31) generating a sent window value (VFE) based on said signal

10      (NIV) in order to process the detected datagram by entering said sent window value

11      (VFE) into said received window value in said field (28), the sent window value

12      (VFE) being at least equal to a remaining window value (VFER) representing, for

13      each connection established, the number of bytes transmittable at the time the sent

14      window value is generated and;

15      - a fourth step (32) routing the processed datagram through a second network

16      (17) to a second transport layer (4), which limits said transport layer (4) send rate

17      based on the sent window value (VFE).--

Delete Claim 2, and substitute the following new Claim:

1      --2.    The method according to claim 1, wherein the signal (NIV) is

2      generated by a binary function that results in an alarm state when the fullness level of

3      the queue (20) exceeds a first threshold value.--

Delete Claim 3, and substitute the following new Claim:

1    --3.    The method according to claim 1, wherein the signal (NIV) is

2    generated by means of a polynomial function proportional to the fullness level and

3    inversely proportional to the capacity of the queue (20).--

Delete Claim 4, and substitute with the following new Claim:

1    --4.    The method according to claim 2, wherein the sent window value

2    (VFE) is generated by limiting the received window value (VFR) when the signal

3    (NIV) is in the alarm state.--

Delete Claim 5, and substitute with the following new Claim:

1    --5.    A device for reducing congestion in a network layer (16) of a router

2    machine (15) when it accumulates, in a queue (20) in a memory of said router

3    machine (15), datagrams (12) to be transmitted through a first network (18),

4    comprising means (33) in said memory for detecting any datagram received from said

5    first network (18) wherein a field (28) of a first transport layer (6) contains a received

6    window value (VFR), and means for entering a sent window value (VFE) into said

7    received window value (VFR) based on a fullness level (26) of said queue (20) before

8    routing the detected datagram through a second network (17) to a second transport

9    layer (4), said second transport layer (4) configured to limit its send rate based on the

10   sent window value (VFE), the sent window value (VFE) being at least equal to a

11   remaining window value (VFER) representing, for each connection established, the

12   number of bytes transmittable at the time said number of bytes is generated.--

**IN THE ABSTRACT**:

Please cancel the Abstract in its entirety and substitute the following new Abstract:
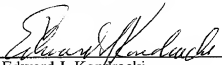
## --ABSTRACT

A router machine (15) is configured to implement a method according to the invention for reducing congestion in its network layer (16) when it accumulates in a queue (20) datagrams (12) to be transmitted through a network (18). The method comprises a first step (29) that measures a fullness level of queue (20), in order to generate a signal (NIV) based on fullness level. A second step (30) detects any datagram received from network (18), wherein a field (28) of a transport layer (6) contains a received window value (VFR). A third step (31) generates a sent window value (VFE) based on signal (NIV) in order to process the detected datagram by entering value (VFE) into said received window value (VFR) in field (28). A fourth step (32) routes the processed datagram through a network (17) to a transport layer (4), which limits its send rate based on the sent window value (VFE).--

# REMARKS

The Preliminary Amendment is made to eliminate informalities in the specification, claims and abstract resulting from a literal translation of the French text, and to insert headings to conform the application to U.S. practice.

The present application is believed to be in condition for examination, which action is earnestly solicited.

Respectfully submitted,
MILES & STOCKBRIDGE P.C.

By: _____
Edward J. Kondracki
Registration No. 20,604

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**Marked Up Version With Markings To Show Changes Made**

**IN THE SPECIFICATION:**

Page 1, line 3

The field of the invention is that of communication networks <u>and are more particularly, communication networks using</u>[. In order to communicate] data terminal equipment units (DTEs) [adapted to] use various protocols.

Page 7, line 21

VFER [-] $\equiv$ VFEp - Diff.

**IN THE CLAIMS:**

1      1.      <u>A method</u> [Method] for reducing congestion in a network layer (16) of
2      a <u>router</u> machine (15) when [it] <u>said network layer (16)</u> accumulates in a queue (20)
3      datagrams (12) to be transmitted through a <u>first</u> network (18), [characterized in that it
4      comprises] <u>comprising</u>:
5           - a first step (29) [that measures] <u>measuring</u> a fullness level of said queue (20),
6      in order to generate a signal (NIV) based on said fullness level;
7           - a second step (30) [that detects] <u>detecting</u> any datagram received from said
8      network (18), wherein a field (28) of a <u>first</u> transport layer (6) contains a received
9      window value (VFR);
10          - a third step (31) [that generates] <u>generating</u> a sent window value (VFE)
11     based on said signal (NIV) in order to process the detected datagram by entering said
12     <u>sent window</u> value (VFE) into said <u>received window value</u> [it] in said field (28), the
13     sent window value (VFE) being at least equal to a remaining window value (VFER)

14    representing, for each connection established, the number of bytes transmittable at the

15    time it is generated;

16        - a fourth step (32) <u>that routes</u> [routing] the processed datagram through a

17    <u>second</u> network (17) to a <u>second</u> transport layer (4), which limits <u>said transport layer</u>

18    <u>(4)</u> [its] send rate based on the sent window value (VFE).

1         2.    <u>The method</u> [Method] according to claim 1, [characterized in that]

2     <u>wherein</u> the signal (NIV) is generated by [means of] a binary function that results in

3     an alarm state when the fullness level of the queue (20) exceeds a first threshold

4     <u>value</u>.

1         3.    <u>The method</u> [Method] according to claim 1, [characterized in that]

2     <u>wherein</u> the signal (NIV) is generated by means of a polynomial function proportional

3     to the fullness level and inversely proportional to the capacity of the queue (20).

1         4.    <u>The method</u> [Method] according to claim 2, [characterized in that]

2     <u>wherein</u> the sent window value (VFE) is generated by limiting the received window

3     value (VFR) when the signal (NIV) is in the alarm state.

1         5.    [Device] <u>A device</u> for reducing congestion in a network layer (16) of a

2     <u>router</u> machine (15) when it accumulates, in a queue (20) in a memory of said <u>router</u>

3     machine (15), datagrams (12) to be transmitted through a <u>first</u> network (18),

4     [characterized in that it comprises] <u>comprising</u> means (33) in said memory for

5     detecting any datagram received from said [first] network (18) wherein a field (28) of

6     a <u>first</u> transport layer (6) contains a received window value (VFR), and <u>means</u> for

7   entering a sent window value (VFE) into <u>said received window value (VFR)</u> [it] based

8   on a fullness level (26) of said queue (20) before routing the detected datagram

9   through a <u>second</u> network (17) to a transport layer (4), <u>said second transport layer(4)</u>

10  <u>configured to limit</u> [which limits] its send rate based on the sent window value (VFE),

11  the sent window value (VFE) being at least equal to a remaining window value

12  (VFER) representing, for each connection established, the number of bytes

13  transmittable at the time <u>said number of bytes</u> [it] is generated.


**IN THE ABSTRACT:**

A <u>router</u> machine (15) <u>is configured to implement</u> [constituting the router

implements] a method [according to the invention] for reducing congestion in its

network layer (16) when it accumulates in a queue (20) datagrams (12) to be

5   transmitted through a network (18). The method comprises<u>:</u> a first step (29) that

measures a fullness level of [said] queue (20), in order to generate a signal (NIV)

based on said fullness level[;]<u>.</u> <u>A</u> [a] second step (30) [that] detects any datagram

received from [said] network (18), wherein a field (28) of a transport layer (6)

contains a received window value (VFR) [;]<u>.</u> <u>A</u> [a] third step (31) [that] generates a

10  sent window value (VFE) based on [said] signal (NIV) in order to process the

detected datagram by entering [said] value (VFE) into <u>said received window value</u>

<u>(VFR)</u> [it] in [said] field (28) [;]<u>.</u> <u>A</u> [a] fourth step (32) [that] routes the processed

datagram through a network (17) to a transport layer (4), which limits its send rate

based on the sent window value (VFE).

15  [Fig. 4]

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## METHOD FOR REDUCING CONGESTION IN A NETWORK

The field of the invention is that of communication networks. In order to communicate, data terminal equipment units (DTEs) use various protocols.

5      Normally, there are several communication layers, for example an application layer, a transport layer and a network layer. The application layer is not directly concerned with the locations where functions are executed. To give a non-limiting example, there are various protocols that are usable in an application layer, such as TELNET for coupling a local terminal with a remote machine, FTP for transferring
10    files between machines, and HTTP for accessing web pages. Generally, a client application sends requests to a server application, from which it receives responses without being concerned with the fact that the server application may be running in a physical and logical environment different from that of the client application. The function of the transport layer is to allow two applications to communicate by
15    accommodating the physical and logical environment of each of them. There are protocols for the transport layer that are connected, such as TCP, and protocols that are connectionless, such as UDP. The advantage of a connected transport protocol is that it ensures the reliability of the exchanges, while a connectionless protocol provides greater speed. The function of the network layer is to route the messages
20    between two DTEs while adapting to the networks to which the two DTEs are connected. For example, network protocols such as IP or CLNP provide a connectionless service of the datagram type. This means that for a message composed of datagrams, the network protocol retransmits each datagram from machine to machine based on the availability of the paths offered, without ensuring that each
25    datagram sent actually arrives at its destination, for example in case of congestion in a network or an intermediate machine. Such an intermediate machine, responsible for propagating the datagrams between two different networks, is generally called a router. According to the recommendation I.113 ITU-T "Vocabulary of Terms for Broadband Aspects of ISDN," Helsinki, March 1993, a connectionless service is
30    defined as a service that allows the transfer of information between two users of the service without any need for procedures for establishing end-to-end calls.

When the number of datagrams to be propagated between two networks exceeds the transmission capacity of the router, the datagrams are placed in queues

inside the router in order to be processed later. When the number of datagrams waiting to be processed in a queue exceeds a threshold, the router discards any new datagrams that arrive that would take up space in this queue because the storage capacity of the router is limited.

5      The result of these delay and loss phenomena is that, in case of congestion, the transport layers of the DTEs re-send, increasing the number of datagrams to be propagated by the router and thus aggravating the congestion.

Known solutions exist at the transport layer level, such as for example the Slow Start with Congestion Avoidance of the TCP protocol. The transport layer of the
10     sending DTE detects the network congestion when it realizes that it must retransmit the data. It relieves the routers that its traffic passes through by temporarily and spontaneously reducing its sending capacity for a given connection. This is done, for example, by increasing the time interval between two possible retransmissions, or by sending a smaller quantity of information than is acceptable by the receiving DTE.
15     One drawback of this solution is that it is used when the congestion has already occurred, so retransmission is inevitable, and the need to delay it further considerably reduces communication performance.

Another example is the Source Quench of the ICMP control protocol. When the router realizes that the number of messages in a queue reaches an intermediate
20     threshold the moment a new datagram is placed in the queue, it sends a particular message to the DTE that sent the datagram, in order to tell it that the risk of congestion has increased. The sending DTE then reduces its sending capacity. One drawback of this solution is that the sending DTE is not clearly informed as to when it can increase its speed again. Moreover, this solution makes it necessary to send
25     additional messages through the networks.

In order to control the speed of the sending DTE so as to reduce it before congestion occurs, without generating any additional traffic, the invention uses datagrams that pass through the router in the receiving DTE-to-sending DTE direction, and that contain window information. This window information is
30     generated at the transport protocol level by the receiving DTE in order to inform the sending DTE of the quantity of information that the latter is authorized to send through a connection prior to receiving an acknowledgement indicating that the preceding transmitted information has been correctly received.

The subject of the invention is a method for reducing the congestion in a network layer of a router machine when it accumulates in a queue datagrams to be sent through a network, characterized in that it comprises:

- a first step that measures a fullness level of said queue, in order to generate a signal based on said fullness level;

- a second step that detects any datagram received from said network, wherein a field of a transport layer contains a first received window value;

- a third step that generates a second sent window value based on said signal, in order to process the detected datagram by entering said second value into it in said field;

- a fourth step that routes the processed datagram through a network to a transport layer, which limits its send rate based on the sent window value.

Thus, in an environment with a network protocol that provides a connectionless datagram service and a transport protocol that provides a reliable connection service using a window system to control the flow from end to end, an intermediate machine through which all the datagrams exchanged by two data terminal equipment units pass can control the flow of datagrams passing through it by acting via its network layer on the transport layer of the sending data terminal equipment unit. This offers the advantage of reducing the congestion in the intermediate machine without requiring a particular procedure in the data terminal equipment units.

A preferred exemplary embodiment of the invention is explained in the following description in reference to the figures, in which:

- Fig. 1 shows a router of the prior art;
- Fig. 2 shows a transport layer segment;
- Fig. 3 shows a network layer datagram;
- Fig. 4 shows a router that implements the invention;
- Fig. 5 shows a datagram with window information;
- Fig. 6 shows some steps of the method according to the invention.

Referring to Fig. 1, a sending DTE (data terminal equipment) 1 communicates messages to a receiving DTE 2 using a transport protocol 3. To do this, a transport layer 4 of the DTE 1 generates segments 5 addressed to a transport layer 6 of the DTE 2. More generally, the segments are Transport Data Protocol Units TPDU.

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Referring to Fig. 2, each segment 5 of the transport layer comprises at least one transport field 7. When the message relates to an application, the transport layer 4 receives information from an application layer (not represented) of the machine 1 via an interface 8. The transport layer 4 then incorporates this information into a field 9 of the segment 5.

Referring to Fig. 1, the transport layer 4 transmits the segment 5 to a network layer 10 of the DTE 1 via an interface 11.

Referring to Fig. 3, the network layer 10 juxtaposes a field 13 with the segment 5 so as to create a datagram 12 addressed to a network layer 14 of the receiving DTE 2. The field 13 contains data for implementing a network protocol between the DTEs 1 and 2. If, for example, the network is an IP network, the field 13 contains an IP address that identifies the receiving DTE 2 and an IP address that identifies the sending DTE 1.

Depending on the topological configuration of the network, the datagram 12 is routed directly from the DTE 1 to the DTE 2 or indirectly through one or more units of router equipment 15. Referring to Fig. 1, the network layer 10 routes the datagram 12 to a network layer 16 of a unit of router equipment 15, through a physical layer 17. The network layer 16 then routes the datagram 12 to the layer 14 through a physical layer 18. When the physical layer 18 is not directly connected to the DTE 2, the datagram 12 passes through as many units of router equipment as necessary in order to reach a physical layer to which the DTE 2 is directly connected.

When the network layer 16 of the router equipment 15 receives a datagram 19 that it cannot immediately retransmit through the physical layer 18 due to congestion, it accumulates the datagram 19 in a first queue 20, which it empties as the physical layer 18 becomes available.

When the network layer 14 of the DTE 2 receives the datagram 12, it extracts the field 13 from it in order to transfer it in the form of a segment 5 to the transport layer 6 via an interface 21. When the segment 5 comprises a field 9 addressed to an application, the transport layer 6 transfers the field 9 to an application layer (not represented) of the DTE 2 via an interface 22. In addition, the transport layer 6 sends the transport layer 4 an acknowledgement segment to inform it that it has actually received the segment 5. To do this, the transport layer 6 transmits the acknowledgement segment, which generally comprises only the field 7, to the

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network layer 14. The network layer 14 then juxtaposes a field 13 with the field 7 in order to obtain an acknowledgement datagram, which is routed to the network layer 10. The network layer 10 then transmits the field 7 of the acknowledgement datagram to the transport layer 4 via the interface 11.

5      Referring to Fig. 1, the network layer 14 routes the datagrams through the physical network 18 to the network layer 16 of the router equipment 15, which reroutes them through the physical network 17 to the network layer 10. When the network layer 16 of the router equipment 15 receives a datagram 24 that it cannot immediately retransmit through the physical network 17 due to congestion, it

10     accumulates the diagram 24 in a second queue 25, which it empties as the physical network 17 becomes available.

A window system of the transport protocol informs the transport layer 4 of the quantity of information it can send to the transport layer 6 prior to receiving the acknowledgement segment. To do this, the transport layer 6 regularly sends segments

15     containing an indicator of the quantity of information it can process without becoming saturated. A simply way to do this is to enter this indicator, for example, into the field 7 of the acknowledgement segments.

Several reasons can cause the transport layer 4 not to receive acknowledgement for segments generated and sent to the transport layer 6. For example, the segments generated and sent to the transport layer or the

20     acknowledgement segments may be lost in the network layers. The transport layer 4 can then re-send unacknowledged segments until it receives acknowledgement for them.

Referring to Fig. 4, the router machine 15 comprises a device for reducing congestion in the network layer 16 when it accumulates, in the queue 20, datagrams

25     12 to be sent through the network 18. The device comprises means 33 for detecting any datagram received from the network 18 wherein a field 28 of the transport layer 6 contains a received window value VFR, and for entering a sent window value VFE into it based on a fullness level 26 of the queue 20 prior to routing the detected

30     datagram through the network 17 to the transport layer 4. When the fullness level of the first queue 20 exceeds a warning threshold 26, the network layer 16 detects the acknowledgement datagrams 27 coming from the network 18 and processes the content of their field 28 before retransmitting them through the network 17. The

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processing of the field 28 is done so that the window value slows the flow of datagrams entering the router 15 addressed to the network 18. The network layer 10 then receives the datagram 27 with a window value in the field 28 that not only takes into account the processing capacity of the transport layer 6 but also takes into account the processing capacity of the network layer 16. The network layer 10 extracts or moves the field 13 of the datagram 27 in order to obtain a segment to be transmitted to the transport layer 4. Based on the window value of the field 28, the transport layer 4 then generates a number of datagrams addressed to the transport layer 6 that is less than or equal to the number of datagrams acceptable by the transport layer 6 of the DTE 2.

Referring to Fig. 6, a method for reducing congestion in a machine comprises four steps. A first step 29 measures the fullness level of the first queue 20 of the datagrams to be sent through the network 18, in order to generate a signal NIV. A second step 30 detects the datagrams coming from the network 18 containing the field 28 with a received window value VFR. A third step 31 processes the value VFR so as to generate a sent window value VFE and to replace the value VFR with the value VFE in the detected datagram, based on the signal NIV. A fourth step 32 retransmits the detected datagram through the destination network 17.

The method, although implemented at the level of the network layer 16 of the router equipment 15, by replacing the window value VFR with the value VFE, modifies a field of the transport layer. It is necessary to comply with the constraints linked to the transport protocol. Step 30 therefore begins by identifying the transport protocol in the field 7 of the datagram received.

For example, in the case of the known transport protocol TCP, the segments are transmitted in byte sequences, each numbered from the first to the last byte in the sequence. Upon receiving the last byte of a sequence, the transport layer 6 of the receiving DTE 2 sends an acknowledgement if this is the first sequence or if it has already sent an acknowledgement for the sequence that immediately preceded it. This acknowledgement generally indicates the number of the first byte of the next sequence waiting to be received. In the same segment that contains the acknowledgement, the receiving DTE 2 sends a window value VFR representing the number of bytes that the sending DTE 1 can send in the sequences to come. The value VFR takes into account any value that may have already been transmitted with a

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previous acknowledgement, indicating the number of bytes already received and the number of bytes that are acceptable on the receiving end.

For each connection established between the transport layers 4 and 6 wherein the datagrams of the network layers 10 and 14 pass through the network layer 16 of the router equipment 15, the router equipment 15 detects the upstream transport protocol type. If the transport protocol detected is the TCP type, the router equipment 15 calculates, in parallel with steps 29 through 32, a remaining window value VFER representing the number of bytes that the sending DTE 1 can still transmit at the moment this value is calculated. In order for the remaining window value VFER to represent reality, it is essential to force all the datagrams in the same connection to pass through the router equipment constituted by the machine 15.

The remaining window value VFER is calculated in the following way. Each time the means 33 receive a datagram containing an acknowledgement, the value it indicates is stored in a variable named ACK. A variable ACKp, initialized at zero, contains the value indicated by the previous acknowledgement. A value Diff is calculated by the formula:

$$Diff = ACK - ACKp$$

The value Diff therefore represents a number of bytes sent in a window VFEp previously transmitted to the DTE 1. The value VFER is therefore given by the formula:

$$VFER - VFEp - Diff.$$

The value VFE obtained in step 31 is therefore equal to the larger of two window values VFER and VFI, where VFI is an intermediate window value calculated based on various possible implementations as explained in the description below, the choice of which is left to a network administrator.

$$VFE = \max (VFER, VFI)$$

This makes it possible to ensure that the value VFE is never lower than the window value VFER for which DTE 1 will continue to transmit bytes prior to receiving the new window value VFE.

According to a first possible implementation, in step 29, the signal NIV is set to a binary alarm state when the fullness level exceeds a first threshold. In step 31, when the signal NIV is in an initial state, the value VFI is equal to the value VFR, and it is the transport layer 6 that imposes the window value on the transport layer 4 in

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order to regulate its sending of datagrams. Steps 30 and 31 can be short-circuited, i.e., the datagrams with windows can be retransmitted directly from the network 18 to the network 17. When the signal NIV is in the binary alarm state, the value VFI is obtained by taking the lower value of the value VFR and a predetermined offset value VFT based on the capacity of the network 18 to empty the queue 20. This has the effect of momentarily reducing the exchanges in high-speed transport layers 4, 6 without necessarily reducing them in low-speed transport layers 4, 6, whose window values are already lower than the offset value VFT. A variant consists of obtaining the value VFI by multiplying the value VFR by a coefficient of less than one. This has the effect of momentarily reducing the exchanges in all of the transport layers 4, 6 in a proportionally identical way, for both low-speed layers and high-speed layers. When the signal NIV is reset to the initial state, the datagrams with the window value VFR are once again retransmitted normally. The signal NIV is reset to the initial state in step 29 when the fullness level falls below the first threshold or when the fullness level falls below a second threshold lower than the first threshold. The hysteresis thus induced in the limitation of the size of the windows has the effect of preventing instability. The second threshold can be very low, so as to correspond to an empty state of the queue 20.

According to a second possible implementation, in step 29, the signal NIV is the one's complement of a number TAUX obtained by dividing the measured fullness level by the total capacity of the queue 20. Thus, when the queue 20 is empty, the signal NIV is equal to one, and when the queue 20 is full, the signal NIV is equal to zero. In step 31, the value VFI is obtained by multiplying the value VFR by the signal NIV. Thus, when the queue 20 is empty, the value VFI is equal to the value VFR and the datagrams remain unchanged. When the queue 20 is full, the value VFI is null, which means that the transport layer 4 can only retransmit a datagram to the network layer 10 after having received an acknowledgement for a preceding transmitted datagram. Between these two extremes, the size of the windows is progressively reduced, with a value VFI between VFR and zero. In case of a momentary overload of the network 18, the fullness level of the queue 20 has a tendency to stabilize around an intermediate value, which makes it possible to anticipate a subsequent load reduction. It is possible to act on this intermediate value by introducing the number TAUX in polynomial form into the calculation of the signal NIV.

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1    1.    Method for reducing congestion in a network layer (16) of a machine
2    (15) when it accumulates in a queue (20) datagrams (12) to be transmitted through a
3    network (18), characterized in that it comprises:
4        - a first step (29) that measures a fullness level of said queue (20), in order to
5    generate a signal (NIV) based on said fullness level;
6        - a second step (30) that detects any datagram received from said network
7    (18), wherein a field (28) of a transport layer (6) contains a received window value
8    (VFR);
9        - a third step (31) that generates a sent window value (VFE) based on said
10   signal (NIV) in order to process the detected datagram by entering said value (VFE)
11   into it in said field (28), the sent window value (VFE) being at least equal to a
12   remaining window value (VFER) representing, for each connection established, the
13   number of bytes transmittable at the time it is generated;
14       - a fourth step (32) that routes the processed datagram through a network (17)
15   to a transport layer (4), which limits its send rate based on the sent window value
16   (VFE).

1    2.    Method according to claim 1, characterized in that the signal (NIV) is
2    generated by means of a binary function that results in an alarm state when the
3    fullness level of the queue (20) exceeds a first threshold.

1    3.    Method according to claim 1, characterized in that the signal (NIV) is
2    generated by means of a polynomial function proportional to the fullness level and
3    inversely proportional to the capacity of the queue (20).

1    4.    Method according to claim 2, characterized in that the sent window
2    value (VFE) is generated by limiting the received window value (VFR) when the
3    signal (NIV) is in the alarm state.

1    5.    Device for reducing congestion in a network layer (16) of a machine
2    (15) when it accumulates, in a queue (20) in a memory of said machine (15),

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3    datagrams (12) to be transmitted through a network (18), characterized in that it
4    comprises means (33) in said memory for detecting any datagram received from said
5    network (18) wherein a field (28) of a transport layer (6) contains a received window
6    value (VFR), and for entering a sent window value (VFE) into it based on a fullness
7    level (26) of said queue (20) before routing the detected datagram through a network
8    (17) to a transport layer (4), which limits its send rate based on the sent window value
9    (VFE), the sent window value (VFE) being at least equal to a remaining window
10   value (VFER) representing, for each connection established, the number of bytes
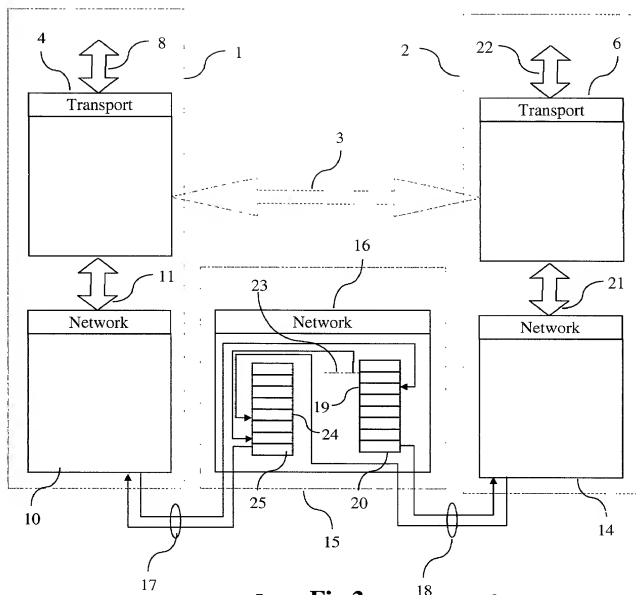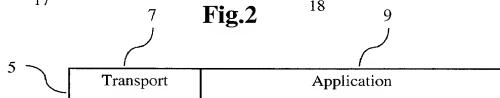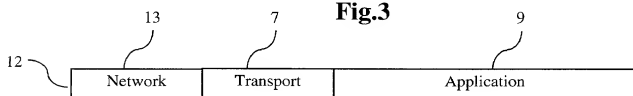11   transmittable at the time it is generated.

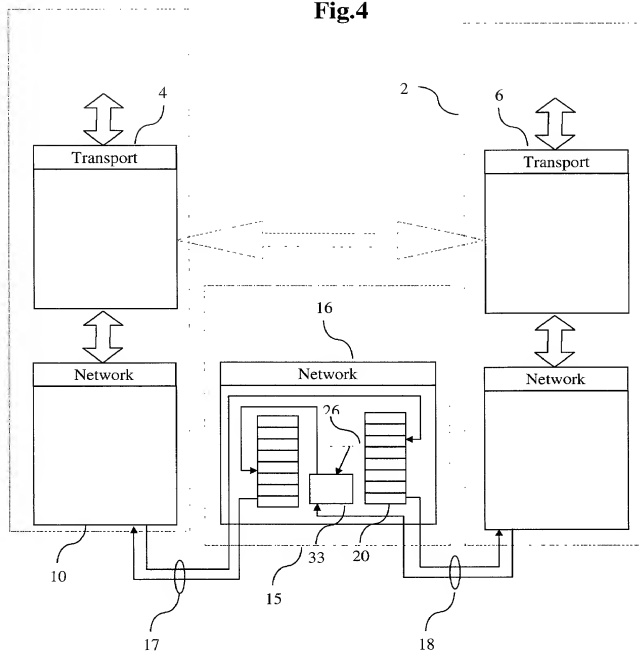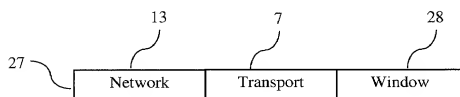# ABSTRACT

## METHOD FOR REDUCING CONGESTION IN A NETWORK

5      A machine (15) constituting the router implements a method according to the invention for reducing congestion in its network layer (16) when it accumulates in a queue (20) datagrams (12) to be transmitted through a network (18). The method comprises:

- a first step (29) that measures a fullness level of said queue (20), in order to
10    generate a signal (NIV) based on said fullness level;

- a second step (30) that detects any datagram received from said network (18), wherein a field (28) of a transport layer (6) contains a received window value (VFR);

- a third step (31) that generates a sent window value (VFE) based on said
15    signal (NIV) in order to process the detected datagram by entering said value (VFE) into it in said field (28);

- a fourth step (32) that routes the processed datagram through a network (17) to a transport layer (4), which limits its send rate based on the sent window value (VFE).
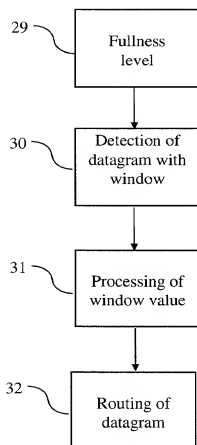
20    Fig. 4

**Fig.1**



**Fig.2**



**Fig.3**

**Fig.4**



**Fig.5**

**3/3**

**Fig.6**

29 — Fullness level

30 — Detection of datagram with window

31 — Processing of window value

32 — Routing of datagram

# Declaration and Power of Attorney For Patent Application
# Declaration Pour Demandes de Brevets Avec Pouvoirs
## French Language Declaration

En tant qu' inventeur nomme ci-après, Je déclare par le présent acte que:

As a below named inventor, I hereby declare that:

Mon nom, mon domicile, mon adresse postale, ma nationalité sont ceux qui figurent ci-après,

My residence, post office address and citizenship are as stated below next to my name,

Je déclare que je crois être l'inventeur original, premier et unique (si un seul nom figure sur le présent acte) ou un des co-inventeurs, originaux et premiers (si plusieurs noms figurent sur le present acte) du sujet revendiqué et pour liquel un brevet est demande sur la base de l'invention intitulée:

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

__Routeur pour interconnexion de réseaux__

_____

_____

_____

_____

_____

_____,

dont la description
(cocher la case correspondante)

the specification of which

(check one)

☒ est annexée au présent acte.

☐ is attached hereto.

☐ a été déposée _____

☐ was filed on _____ as

  Numéro de série de la demande _____

  Application Serial No. _____

  et modifiée le _____
                    (si approprié)

  and was amended on _____
                           (if applicable)

Je déclare par le présent acte avoir examiné et compris le contenu de la description identifiée ci-dessus, revendications y compris, et le cas échéant telle que modifiée par l'amendment cité plus haut.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

Je reconnais le devoir de divulguer l'information qui est en rapport avec l'examen de cette demande selon Titre 37 du Code des Reglements Fédéraux §1.56(a).

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

# French Language Declaration

Je revendique par le présent acte le bénéfice de priorité étrangère selon Titre 35, du Code des Etats-Unis, §119 de toute demande de brevet ou d'attestation d'inventeur énumérée ci-après, et j'ai identifié également ci-après toute demande étrangère de brevet ou d'attestation d'inventeur ayant une date de dépôt antérieure à celle de la demande pour laquelle la priorité est revendiquée.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior foreign applications

Demande(s) de brevet antérieure(s) dans un autre pays:

Priority claimed

Droit de priorité revendiqué

| FR 9911592 | France | 16 09 1999 | ☒ Yes / Oui | ☐ No / Non |
|---|---|---|---|---|
| (Number) (Numéro) | (Country) (Pays) | (Day/Month/Year Filed) (Jour/Mois/Année de dépôt) | | |
| (Number) (Numéro) | (Country) (Pays) | (Day/Month/Year Filed) (Jour/Mois/Année de dépôt) | ☐ Yes / Oui | ☐ No / Non |
| (Number) (Numéro) | (Country) (Pays) | (Day/Month/Year Filed) (Jour/Mois/Année de dépôt) | ☐ Yes / Oui | ☐ No / Non |

Je revendique par le présent acte, le bénéfice selon Titre 35 du Code des Etats-Unis, §120 de toute(s) demande(s) américaines énumérée(s) ci-après et, dans la mesure où le sujet de chacune des revendications de cette demande n'est pas divulgué dans la demande américaine antérieure, de la façon définie par le premier paragraphe de Titre 35 du Code des Etats-Unis, §112, je reconnais le devoir de divulguer l'information pertinente selon Titre 37 du Code des Règlements Fédéraux, §1.56(a), toute information qui se présente entre la date de dépôt de la demande antérieure et la date de dépôt de la demande, soit nationale, soit internationale PCT.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

| (Application Serial No.) (No. de Demande) | (Filing Date) (Date de Depôt) | (Etat) (brevetée, pendante, abandonné) | (Status) (patented, pending, abandoned) |
|---|---|---|---|
| (Application Serial No.) (No. de Demande) | (Filing Date) (Date de Depôt) | (Etat) (brevetée, pendante, abandonnée) | (Status) (patented, pending, abandoned) |

Je déclare par le présent acte que toutes mes déclarations, à ma connaissance, sont vraies et que toutes les déclarations faites à partir de renseignements ou de suppositions, sont tenues pour être vraies; de plus, toutes ces declarations ont été faites en sachant que de fausses déclarations volontaires u autres actes de même nature sont sanctionées par une amende ou un emprisonnement, ou les deux, selon la Section 1001, du Titre 18 de Code des Etats-Unis et que de selles déclarations délibérément fausses peuvent compromettre la validité de la demande ou du brevet délivré.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

# French Language Declaration

POUVOIR: En tant qu'inventeur, je désigne l'(les) avocat(s) et/ou l'(les) agent(s) suivant(s) pour poursuivre la procédure de cette demande et traiter toute affaire la concernant supris du Bureau des Brevets et de Marques:

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (*list name and registration number*)

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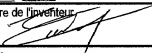| Nom complet du second co-inventeur, le cas echeant | Full name of second joint inventor, if any |
|---|---|
| **MAINGUENAUD Bernard** | |
| Signature de l'inventeur · · · · · · · · · · · · · · · Date 4 octobre 1999 | Second Inventor's signature · · · · · · · · · · · · · · · Date |
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(Fournir les mêmes renseignements et la signature de tout co-inventeur supplémentaire.)

(Supply similar information and signature for third and subsequent joint inventors.)

Page 3 of 3

## French Language Declaration

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| Signature de l'inventeur            Date | Inventor's signature            Date |
| Domicile | Residence |
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| Nationalité | Citizenship |
| Adresse Postale | Post Office Address |
| - | |
| | |
| Nom complet du cinquième inventeur | Full name of fith joint inventor, if any |
| Signature de l'inventeur            Date | Inventor's signature            Date |
| Domicile | Residence |
| - | |
| Nationalité | Citizenship |
| Adresse Postale | Post Office Address |
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